DOCUMENT RESUME

ED 211 957 CS 006 466

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TITLE Reading: Cognitive Input and Output.
PUB DATE Jan 82
NOTE 21p.; Paper presented at the Annual Meeting of the Claremont Reading Conference (49th, Claremont, CA, January 14-15, 1982).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Beginning Reading; *Cognitive Development; *Cognitive Processes; Elementary Education; *Language Acquisition; Language Experience Approach; Learning Theories; Models; *Oral Reading; Reading Instruction; Reading Processes; Reading Skills; *Silent Reading

ABSTRACT

Descriptions of language learning and reading behaviors are presented, in this paper, within the context of a model of cognitive processing that reflects a continuum for the logical procession of language skills in human maturation and learning. Portions of the paper differentiate silent and oral reading in terms of cognitive load, which is a function of the complexity and relative difficulty of the processing task at any point along the continuum. Examples are offered to show that the cognitive load of a reading task is not equal among all children and may be heaviest for those who tend to have language, speech, or auditory input variations from the accepted textual norm, or who manifest unstable, immature visual/perceptual reading skills. The final portion of the paper examines the instructional implications of the cognitive processing model, noting that silent reading must be linked to substantive subject matter and that the language experience approach is useful in beginning reading instruction. (RL)

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READING: COGNITIVE INPUT AND OUTPUT

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Reading: Cognitive Input and Output

In general, linguistic based reading systems appear to focus primarily on the application of phonology to word attack skills and on the development of reading materials based on a knowledge of natural language structures. Psycho-linguistics, considered from the focal point of cognitive processing, has specific contributions to make to instructional methods in reading, to diagnosis and assessment of reading problems and to the substantative content to be read. Although the physical act of reading is significant and clearly essential, the central core of reading competency is built around the ability to process meaning from the arbitrary code characteristic of a particular language. Visual perceptual skills and the ability to retain complex serial patterns of abstract graphic configurations in short and long term memory are essential prior to beginning to read. If there are neither peripheral (end organ) nor cortical visual deficits, the child usually has the necessary visual competencies by age four. Even when his early environment has not provided the expected auditory/speech verbal coding for such parameters as shape, size, color and number, he can acquire them rapidly. For all children, beginning reading/learning experiences should provide systematic exposure to modes by which visual and

auditory stimuli can be organized, stored in short and long term memory and retrieved rapidly and precisely. Such readiness exercises are related directly to the cognitive tasks basic to reading.(1)

For the normal sighted individual, reading is the single most efficient route to learning. All other existing modes of information input are too slow and too inaccurate to provide the continuous flow of exact information that must be processed. Speech rates of 100 to 120 words per minute and the wide range of individual differences in auditory processing skills make the acquisition of learning beyond the fourth grade almost wholly dependent upon reading competency.

There is general concern that many students have not achieved a level of skill requisite for independent learning through reading. Because each individual develops uniquely with respect to neuro-physiological and psychological maturation, it is obvious that deficits in intellect, in sensory-motor and emotional integrity must be compensated for in the learning program. Although reading is a language centered process, it is a complex perceptual-cerebral activity using linguistic materials and content based upon an abstract visually perceived graphic code arbitrarily representative of an established

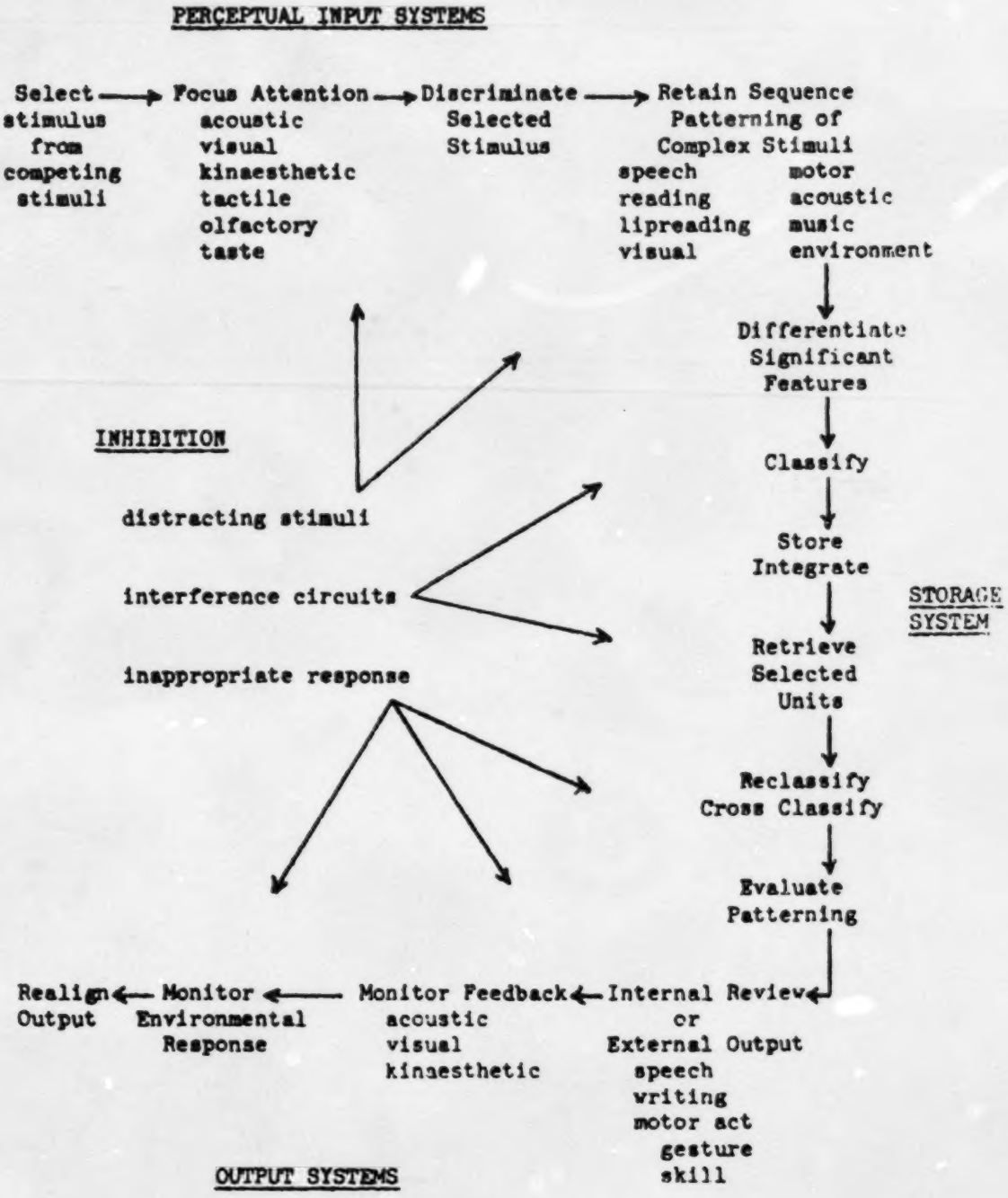
auditory code, often without a one to one correspondence between the symbols. For example, there is the variant spelling of the homophone/SENT/ in these contexts:

I have only one _____.(cent)
The skunk has a familiar _____.(scent)
The boy went where he was _____.(sent)

Spelling conventions may have historic antecedents with little consistency in current application.

While individuals vary significantly in developmental rate, there is a continuum along which a logical procession of skills may be observed in human maturation and learning. This continuum (Table I) may be viewed as a model of cognitive processing within which silent and oral reading may be differentiated with respect to cognitive load.

Cognitive load is a function of the complexity and relative difficulty of the processing task at any point along the continuum. The same task may vary in load with experience, practice, maturation, motivation, anxiety and previous learning of related skills and knowledge. The concept of a cognitive continuum is particularly useful in assessment, diagnosis, curricular development and the individualization of learning. However, when we evaluate any mechanistic model of cognition, we must not be trapped in the analogy of the computer. Research has not yet



KOPP: COGNITIVE PROCESSING MODEL (1968)

(1) Curriculum: Cognition and Content. Ed. Kopp, H.G. Volta Review, 1968, p. 377.

solved the mystery of memory nor the specific manner by which stimuli are organized and stored. The computer analogy is tempting when we realize that the human brain has several billion cells, most of which are unused. In a single area, such as the cerebellum, each brain cell can make more than 500,000 contacts with other cells.

Experimentation over the past 20 years into the effect of environment upon animal brains has shown that animals examined after 80 days spent in stimulating environments had larger and heavier brains with better blood supply than did animals kept in isolation without toys. Only one variable was found to have a significant effect on the animal brain. Exercise, visual stimulation, fondling, having animal companions and being taught to manipulate equipment had no significant effect. The only variable that did have a direct positive effect on brain development was the opportunity for the animal to move freely in a large space when it was provided with continuous and varied problems to solve under challenging conditions.

Cognition must be an independently performed activity. It is not an animalistic, cued, conditioned response. Each subskill on the continuum must be developed to the degree at which it may be carried out rapidly and

efficiently. It is reassuring to know that the quality and quantity of sensory input can be structured to guide the child in cognitive manipulation of perceived stimuli.(2) Cognitive output has long served as the measurement basis for intelligence and achievement. To our discredit, assessment is often restricted to easily scored behaviors.

Intelligence is not only an abstract-verbal-conceptual or sensori-motor ability. It is environmental adaptation, problem solving, convergent and divergent thinking and the creative manipulation of stored knowledges and skills. Learning must focus on areas of the child's sensory assets in addition to remediation and compensation for areas of deficit or handicap. Priority should be given to an individual's profile of responses along the cognitive continuum and not to a subset of numerical scores nor to comparison with a set of norms representative of a large population but of no single individual.

It is possible to evaluate the cognitive loads imposed by silent and oral reading and thus, to select a preferred reading mode for beginning readers. Silent reading is an input function. Ocular perception is global. That is, the eye perceives large units simultaneously in a single fixation, often referred to as a fixation or visual span. Internal detail and external shape of the

unit perceived may be retained in short or long term memory. Reading of English requires left to right, movement along a horizontal line, from one fixation to the next, with rapid cortical processing of the visual input. It is a single modality function with direct transmission from end organ to cortex. The silent reading process terminates at the storage-integration level on the continuum. Printed stimuli are relatively constant and predictable in form. Hand writing may be more challenging.

The ear perceives temporally. Audition requires the processing of serially perceived stimuli arriving at high speeds, stored in short term memory and then moved into cortical processing. The auditory processing of speech is relatively complex since syllabic combinations have variant forms dependent upon the syllables with which they are articulated, often influenced by phonemes at some distance, either preceding or following. Our spoken language was designed for auditory intelligibility. Alphabetic representations are gross simplifications, unable to symbolize normal phonemic variability.

horse shoe = /hɔɹʃu/ moonbeam = /mumbim/
comfortable = /kʌmftəbl/ what did you say = /hwa djə seɪ

Disregarding the complicating effects of dialect, speaker age, speech defects, environmental noise, listener fatigue,

horse shoe = /hôrshō͞o/ moonbeam = /mō͞omb ē͞m/
comfortable = /kumftu̯bl/
what did you say = /hwa dju̯ sā

Alternative Phonetic Designation

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hearing acuity and the difficulty of the content, at best, the perception of speech is fraught with confusion clarified only by the innate redundancy of spoken language.

The fetus with normal hearing begins to respond to sound by the third month. The ability to discriminate the sounds and syllables of the mother tongue begins so early that the auditory channel is considered as the integrating channel for language input. It should be noted that language learning is relatively complete as an input function by age four, although the output skills lag considerably. Language problems of the hearing impaired are recognized widely, and, if uncompensated, are reflected in speech and reading deficits.(3)

Auditory discrimination of speech requires rapid processing of both segmental features (phonemes, blends, syllables, transitional segments between adjoining sounds, phonemic variations within a speaker and among speakers) and supra-segmental features (inflectional changes, intonation patterns, melodic patterns, phrasing) which add emotional and second-order, non literal meaning to the articulated, phonemic input. It is only the redundancy of speech with consequent opportunities for auditory closure that permits intelligibility under other than ideal conditions.

The cognitive task in oral reading involves a cross-modality transfer. The child perceives a visual code as input, but as output, is required to produce sounds acquired through an auditory code system. Analysis of the cognitive load reveals the areas of potential difficulty, especially in an immature system in which visual perceptual and decoding processes may not be established firmly.

The cognitive processing model (Table I) may be used to identify the variables of silent reading: visual code perception, discrimination, recognition, memory (storage) and association with meaning (integration). Oral reading requires that the individual produce the appropriate motor behaviors associated with spoken output of the auditory code thus demanding rapid linkage between the visual and auditory/speech codes. Production of speech is monitored internally by the speaker's kinaesthetic and auditory feedback, and may be monitored externally by teacher feedback. When oral reading is a function of a group process and the listening child follows in his text the oral reading of others, he becomes the victim of variable auditory input related to a non-varying visual code. When the teacher reads, presumably the auditory input is high quality and at less than a normal speech rate of 100 to 120 words per minute. Fluent silent readers

can process at 1,000 words per minute. What happens to the development of visual perceptual skills when the child tries to follow in his text as someone else reads aloud? The child is taught ocular regression, especially when the teacher stops at a significant word and says, "Point to 'chair'". What happens when another child reads, with limited fluency, requiring teacher assistance in word attack, lacking normal inflection and phrasing, and perhaps, even with a speech defect? What is the effect on the listening child's visual and auditory processing? How does he link the two codes? Does he store a number of variant pronunciations for instant linkage with an invariant visual code for a particular word or word group? To make the problem even more serious, how does the auditory input from oral reading relate to the pre-acquired auditory input from perception of speech. For example:

visual code	oral reading-auditory	speech-auditory
What is the matter?	hwat ɪz ðə mætr	hwatsə mætr
Where are you going?	hwɛr ar ju gouwɪŋ	hwɛr: ə jə gouwɪŋ

If the child's speech patterns are coded in less than fluent English, in a non-fluent Bi-lingual system, if he speaks a variant form of English such as Black English, or if he speaks a dialect form of English, there are additional problems.

visual code	oral reading-auditory	speech auditory
I am late	aɪ æm leit	a biz lɛɪt

visual code	oral reading-auditory	speech-auditory
What is the matter?	ˌmat ɪz ðu mætr	ˌmats u mǽtr
Where are you going?	ˌmer ar yʊo gōwɪng	ˌmer ụ yụ gō wɪng

visual code	oral reading-auditory	speech-auditory
I am late	ɪ̄ am lāt	a bēz lāt

Alternative Phonetic Designation

The requisite internalized translation among codes may produce: a processing lag in interpreting meaning; confusion among and within auditory and visual codes; and, ultimately, disinterest in a difficult and ungratifying cognitive task. It is clear, that, at best, the cognitive load is not equal among all children and may be heaviest for those who tend to have language, speech or auditory input variations from the accepted textual norm and unstable, immature, visual perceptual reading skills.

Fluent oral reading requires relatively stable ocular habit patterns. The eye-voice span for the experienced oral reader permits the eye to move ahead several fixations beyond speech output, retaining the text in memory; then, moving ahead to a new, advanced fixation span as the gap is narrowed between input and processing of the visual code and the speech output. The oral reader with immature visual habit patterns and relatively unstablized processing skills tends to regress frequently, maintain a narrow eye-voice span, and use a narrow fixation span. At worst this becomes word-calling, difficult for both reader and listener to process for textual meaning. If oral reading errors are corrected, the attention set shifts from reading to speech. The pleasure experienced by the child reader is questionable,

the agony is often apparent in his frustration and in the inattention and distractability of his peers. For the fluent silent reader, the auditory input from others reading aloud may be a source of confusion or distraction. For all young oral readers, habits of sub-vocal speech are encouraged and tend to persist.

Alternative oral response patterns with reduced cognitive load are available to evaluate reading skills and comprehension. The option of silent reading of a phrase or sentence, then repeating it without looking at the text involves a serial progression of cognitive tasks but a lighter cognitive load than oral reading, even though it requires visual processing, storage, retrieval from memory and oral output. Retelling a passage after reading it silently is a significantly lighter load with the advantage of facilitation of desirable skills including memory and retrieval of input in logical sequence. Once silent reading habits have been established, the oral reading and interpretation of familiar material is a pleasurable and reinforcing experience.

Silent reading skills and comprehension should be tested through silent reading whenever possible to encourage rapid and accurate processing and retrieval. To facilitate cognitive processing, a series of silent reading exercises (4) have been developed for overhead projection with controlled

visual exposure rates. Their goal is to challenge the reader to improve his performance at a conscious level, competing only against himself, while providing immediate feedback and reinforcement. The emphasis is on rate of processing of perceived information, not on reading speed. They are pleasurable and contain substantive content motivating to the reader. Most are adaptable to varous reading levels. Each builds on a particular task segment of the cognitive continuum (Table I).

The requirement for written response may be circumvented by the use of vocabulary storage systems of word or phrase cards to be manipulated by mounting in individual envelope charts permitting immediate teacher feedback. Until hand written responses are facile, their use in the assessment of reading incorporates an additional cognitive load. The necessary post-mortem spelling and writing corrections may add to the child's distaste for reading. Writing of language is an output function. Although closely linked to reading input, the initial development of writing should be as an output function and expressive mode. However, the child's progress in silent reading should not be limited either by his speech or writing competencies.

In general, receptive control of syntax precedes expressive control by at least two months. The order by size and use in which various vocabularies are developed is particularly relevant to the teaching of reading (5).

Vocabularies in Order of Size, Complexity and Use

Pre School	Primary	Lower Elem.	Upper Elem.
1. auditory	1. auditory	1. auditory	1. reading
2. speech	2. speech	2. reading	2. writing
	3. reading	3. speech	3. auditory
	4. writing	4. writing	4. speech

In each instance, the vocabulary of lower order, size and complexity, with one as the highest, is subsumed in the next highest vocabulary. Thus many words are read and understood by the adult that are found neither in his auditory input nor in his writing and speech output vocabularies. The educated adult may use only 5,000 words of the 600,000 available in English and of the 30,000 or more that he comprehends in reading.

To encourage the purposeful, independent use of reading as a tool for acquiring information, silent reading must be linked to substantive subject matter rather than pursued in the content vacuum of controlled readers. Easy access to a wide variety of resource materials is essential. The writing and reading of experience stories, logs, diaries, science research reports and abstracts

provides for a mutually reinforcing interaction between reading and writing skills. Beginning Readers should be written by the students through oral language output dictated to a skilled Teacher and used as a means of sharing and recalling pleasurable learning experiences. Science experiments, trips, social interaction, lunch menus, bus routes, maps, weather reports, dramatized stories, puppet shows, and family news items provide a base for the development of vocabulary, the generation of conceptual thinking, practice in logical ordering of language and events and an hypothesis framing approach to problem solving. Success and gratification encourage the child to inhibit those distracting cortical interference circuits that limit his ability to focus and to maintain his attention on the cognitive task. Emphasis on the processing of meaning and the manipulation of language is inherent in maintaining the excitement of reading and writing while one develops the essential decoding and encoding skills.

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